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Review

Scrutinization of Nanoparticles as Potential Toxins

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Abstract

This article offers toxicology effects related to nanoparticles. The nanoparticles including nanocarbon have been used as technological tools, however may cause harmful effects on biosystems and environment. The toxic effects are dependent on several factors such as size, shape, surface area, morphology, and chemical nature. Owing to nanosize, these particles may enter living systems, tissues, microcells, and blood stream. They can interact with living systems, so causing damage in different ways. Consequently, these nanoparticles may harm the normal functioning of biological structures and systems. The main aim of this paper is to highlight the toxic effects, potential hazards, and possible remedies for future advancements in this field.

Keywords: Nanoparticle; nanocarbon; toxicity; effects

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1. Introduction

Nanomaterials, especially carbon-based, have gained immense importance due to enhanced properties [1-11]. Nanoparticles have dimensions existing on nanometric scale (i.e. ≤100 nm). Essential properties of nanoparticles have fine physical properties such as uniformity, conductivity, and optical properties. Significance of carbon nanomaterials have been found in several applications such as energy, defense, construction, materials, and other relevance [12-29]. The scientists and engineers have proposed range of nanoparticles for different kind of improvements in industrial areas. Carbon nanoparticles also have dimensions in the range 0.1-100 nm. These nanoparticles have high physical, chemical, and biological properties. The nanocarbon nanoparticles have high hardness, inertness and corrosion resistance. The systematic investigation of nanoparticles has found them promising for nanoelectronics, nanoengineering, and nanobiomedicine. The surface morphology of nanocarbon has found to influence the adhesion with biosystems and cells. In this paper, implication of carbon and other nanoparticles is important in technical fields. However, toxicology studies on nanomaterials are important to eliminate or minimize the toxic effects on living systems.

2. Properties of nanoparticles associated with function

The physical properties of nanoparticles directly determine the nanoparticle uptake and toxicological effects [30]. The nanoparticle size, surface charge, hydrophilicity, aggregation, dispersion, and solubility influence the chemical and geometrical properties of nanoparticles. Different types of nanoparticles have been prepared for the technical systems (Fig. 1). The tissue distribution of nanoparticles is strictly size dependent. The nanoparticles of 10 nm size are widely dispersed. The large nanoparticles of 50-250 nm were found toxic in liver, brain, and blood.

The nanoparticles smaller than 200 nm may enter the epithelial cells and skin layer. The composite nanoparticles have also been prepared (Fig. 2). The nanoparticle size, morphology, and concentration imitate the cytotoxic effects of these materials. Table 1 summarizes *in vivo* and *in vitro* toxicity of various types of nanoparticles. The toxic effects have been studied for target organs such as lungs, liver, brain, etc.

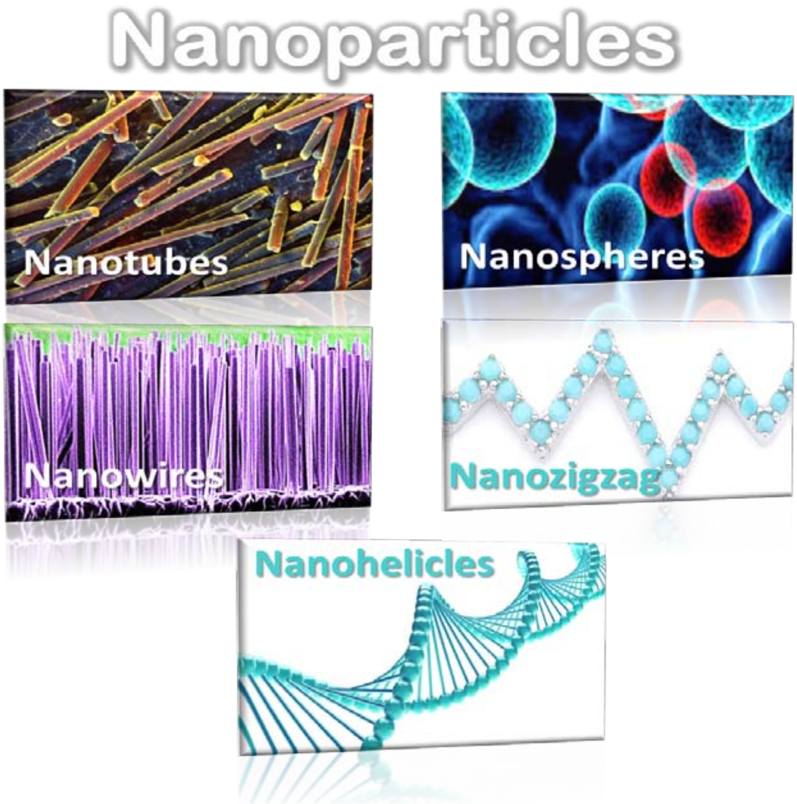

Fig. 1 Morphology of nanoparticles.

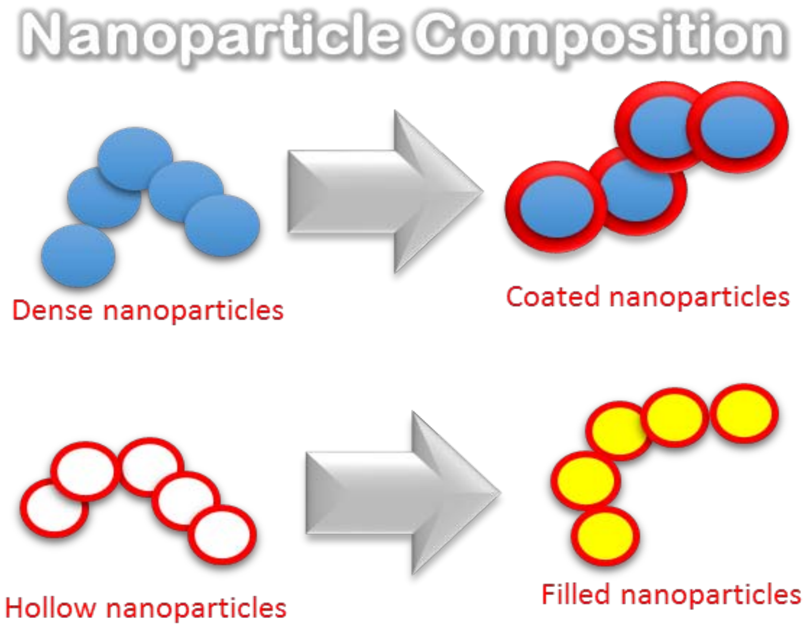

Fig. 2 Composite nanoparticles.

Table 1 Nanoparticle toxicity.

Nanoparticles	Toxic effects
Single-walled carbon nanotube	Acute cytotoxicity, liver toxicity
Multi-walled carbon nanotube	Inflammatory effects on lungs, skin, liver
Gold nanoparticle	Neurotoxicity
Silver nanoparticle	Lungs inflammation
Silica nanoparticle	Stress, cytotoxicity
Ni nanoparticle	Lung/skin inflammation
Cu nanoparticle	Stomach problems
Silica nanoparticle	Pulmonary fibrosis

3. Nanocarbon toxicity

Carbon-based nanoparticles have own fine physical and chemical properties. Carbon nanoparticles possess high electrical conductivity, heat conductivity, mechanical properties, high thermal stability, low toxicity, and environmental friendliness. Carbon nanotube, nanodiamond, graphite, graphene, carbon nanofiber, and other nanocarbon have formed nanoparticle materials [31-40]. Nanocarbon nanoparticles are useful in several technical applications such as supercapacitors, semiconductors, solar cell, fuel cell, and optical devices [41-60]. These nanoparticles have harmful effects on human body and environment. These nanoparticles may induce toxicity related to pulmonary poisonousness, reproductive and developmental injuriousness. The carbon nanoparticles may cause pulmonary, lungs, and skin inflammation. The pulmonary exposure to nanoparticles have also produced damage to other body organs. The exposure to nanocarbon may lead to developmental and growth toxicity (Fig. 3). The nanocarbon may cause hazardous effects similar to asbestos effects.

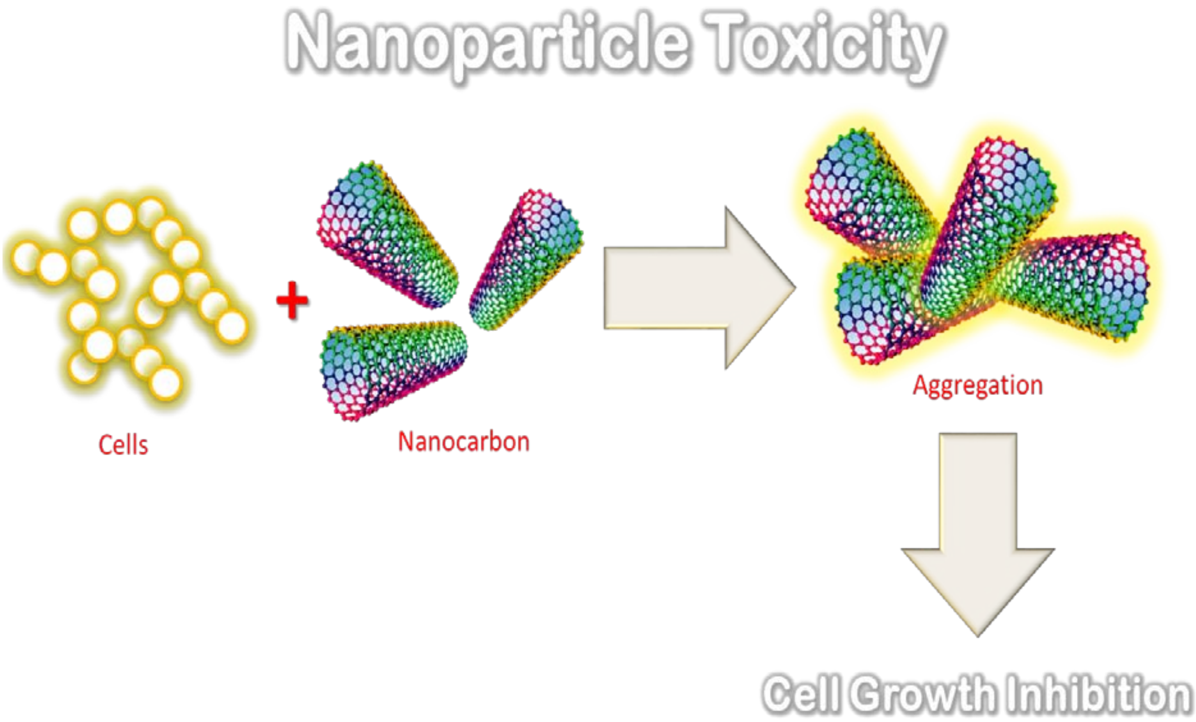

Fig. 3 Toxicity of nanocarbon

4. Conclusions

Nanoparticles have gained importance owing to size, shape, surface area, agglomeration, hydrophilicity and other indispensable properties. There are several beneficial physical and chemical properties of nanoparticles for technical applications. Nanotoxicology is an emerging division of nanotechnology. In this regard, potentiality of nanoparticles is under consideration. The conceivable hostile health effects of nanoparticles have been observed. Owing to nanosize, the nanoparticles may permeate to the biological structures. The nanoparticles may exhibit high toxicity according to the amount, composition, size, and crystalline structure.

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